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THE NEED OF INSULAR EXPLORATION AS ILLUSTRATED BY BIRDS[1]

By ROBERT CUSHMAN MURPHY

AMERICAN MUSEUM OF NATURAL HISTORY

I

IF the track of every civilized inquiring traveler could be accurately plotted on a globe, there is little doubt that all but a few small portions would become entirely black, due to the crossing and merging of the countless lines. This would apply to nearly the whole of the ocean as well as to the lesser area of continents and islands. In short, modern man has seen his world and has mapped with extraordinary faithfulness somewhat more than three quarters of it. The "unknown," in the geographic sense, has become exceedingly restricted. On the other hand, the little known still looms amazingly large. The fact that the scope of knowledge is so vast and human interest so diversified means that only a few centers of ripe culture have been studied in any large proportion of the aspects that man's curiosity makes possible. The great bulk of travelers add much to their own store of information and enjoyment; they may also exert a cumulative influence in the field of international relations. Few of them, however, can be expected to add new accretions to the sum of exact knowledge.

When a well-informed layman begins to acquaint himself with the biological material in a great museum, he is likely to conclude that the fauna of the world has been rather thoroughly collected, preserved, classified and filed, or in other words that the strictly pioneering part of the task of getting acquainted with the earth's inhabitants has been finished. For a few groups be-

[1] An address delivered before the Science Section of the American Association of Museums at the Academy of Natural Sciences of Philadelphia, May 20, 1938.

longing to limited regions, such as the game mammals of the African grasslands, the birds of the British Isles or the fresh-water fishes of the United States, this may be substantially true. But with reference to very many other groups of living organisms, throughout expanses of the continents and oceans alike, the surface has not yet been even deeply scratched. Confining my own remarks to such a conspicuous and relatively well-known class of vertebrates as the birds, I am going to attempt to indicate the rich field for fundamental zoological investigation that still lies before museum men at islands scattered throughout the seven seas and their respective gulfs and bights. The opportunity applies scarcely less, indeed, to numberless small islets on the continental shelves, perhaps within sight of mainland shores, than to remote oceanic dots and archipelagoes lying at distances of hundreds of miles from the nearest extensive seacoast.

"The proof of the pudding is in the eating." In 1920 my own institution began a series of ornithological investigations in the Pacific, known collectively as the Whitney South Sea Expedition. For a decade or longer the schooner *France* was maintained as a base of operations. Before the craft was disposed of, and ever since that time, numerous less elaborately organized projects have been carried on continuously. The field of operations has extended from eastern Polynesia westward to New Zealand, New Guinea and its outliers and Micronesia. Let us consider briefly some of the scientific discoveries made in a region which had already been traversed by countless expeditions and visited by scores or hundreds of naturalists representing many nationalities since the birth of the modern age of scientific inquiry shortly after the middle of the eighteenth century. We shall draw our conclusions entirely from results which have thus far been published.[2]

The ornithological reports by six authorities, the majority of which are from the pen of my colleague, Dr. Ernst Mayr, reveal that up to May, 1938, 12 new genera and 196 new species and subspecies of birds have been described from the Whitney South Sea collections. This number is not unlikely to be doubled during the next few years, but no less important than the disclosing of hitherto unknown animals is the interpretative use to which they have been put. Among problems illuminated by the Whitney expedition, the following are some of those discussed in the publications cited:

Biogeographic phenomena of variation, including those exemplifying Bergmann's rule, *i.e.*, increase of size among closely related birds in direct ratio with higher latitudinal range; apparent evolutionary sequences as correlated with the distances between islands, the direction and force of prevailing winds, and other influences that bear upon obvious probabilities of dispersal and survival; the phenomenon of "swamping" or the breeding out of incipient races because of the ease and consequent frequency of repeated incursions from the populations of other island stations; detailed information on seasonal equatorward migration of certain south-temperate insular birds; distribution through primitive human agency; heterogynism, or the condition in which the diagnostic characters of species and races are exemplified chiefly or exclusively among females; other aspects of sexual dimorphism, including evolutionary reversal in its expression; physiology and genetics of plumage pattern in so far as conditions found in nature can be extrapolated from the data of experimental studies; marked disproportion in the normal relative numbers of the sexes; parallel evolutionary trends exemplified among the races of two or more species within a common genus.

II

"Case histories" offer, no doubt, the best basis for intelligible discussion. From a wealth of examples that are wide-spread in the Pacific—and, for that matter, at islands in other oceans—I shall choose certain warblers (Sylviidae) and flycatchers (Muscicapidae), endemic at the Marquesas Islands. Of the fifteen forms within these two families which inhabit all but one of the islands comprising the archipelago, twelve were made known to science by the Whitney expedition.[3]

Both of these groups of birds belong to widely distributed Old World families. The Marquesas have apparently derived their terrestrial biota, including the native human stock, from the southwest; warblers and flycatchers of the same or nearly related species still inhabit the Society and Tuamotu islands to southward. The subsidiary question as to the times, manner and order in which the birds first occupied nine of the ten islands in the rather remote Marquesas archipelago is more open to conjecture. However, the whole chain lies approximately along the axis of the steady southeast trade wind, and there are numerous indications that taxonomic interrelationship is largely in accord with the theoretical chances of island-to-island transfer.[4]

The warblers of the Marquesas are rather closely

[2] The data are recorded in the introduction and assembled papers of a volume entitled "Birds Collected During the Whitney South Sea Expedition, I–XXV" (articles from the *American Museum Novitates*, 1924–33), published by the American Museum of Natural History, November 6, 1933; also in additional numbers of the same journal (Whitney Expedition reports XXVI–XXXVII), 1933–38, as follows: Nos. 665, 666, 709, 714, 820, 828, 912, 915, 933, 939, 947, 977.

[3] These birds and certain related forms have been described and discussed by Murphy and Mathews, *Amer. Mus. Novit.*, No. 337, 1928, pp. 1–18.

[4] In this connection, Mayr has found that at Rennell Island, an isolated member of the Solomon group, the direction of the prevailing winds and the distance from neighboring archipelagoes are clearly correlated with the percentage of the several faunistic elements (*Amer. Mus. Novit.*, No. 488, 1931, p. 11).

kin to the Eurasian and Australian reed-warblers (*Acrocephalus*). They are of the same species, in my opinion, as the warblers of the Society Islands (*Conoderas caffra*), which lie roughly 800 geographic miles distant. Nine of the ten islands of the Marquesas are inhabited by these birds, and only two of the islands, namely, Hivaoa and Tahuata, which are very close together, share the same geographic race. Each of seven other islands has its own endemic subspecies, differing in size, hue or both from all the warblers of the neighboring islands. In one instance, two islands only a little more than three miles apart (Eiao and Hatutu) are occupied by faintly separate races, illustrating a fact which zoologists have been unduly slow to recognize, *i.e.*, that birds do not always undertake what their wings might make readily possible but that, on the contrary, slight barriers may demarcate for indefinite periods the ranges of closely related forms. Furthermore, it should be observed here that all these Marquesan warblers have exceptionally loose and fluffy plumage, quite unlike the feathering of the active, migratory reed-warblers of Europe. In any event, incipient differentiation is under way between the resident birds of Eiao and Hatutu; as to how much the process may have been inhibited by "swamping" or casual interchange of birds from island to island with consequent back-crossing and leveling, we can not even guess.

Neither have we any means of knowing whether the warblers of Eiao and Hatutu would still be fertile *inter se* if they were brought together, but throughout the archipelago there is a clear correlation, as I have already hinted, between the taxonomic weight of several subspecies and the extent of spatial isolation. For example, the warbler inhabiting Motane Island, which is only ten miles from Hivaoa, is a "weak" subspecies, whereas the warbler of Fatuhiva, an island twenty-five miles from its nearest neighbor and "up wind" from the other islands, is the "strongest" or most highly distinctive race of the whole archipelago.

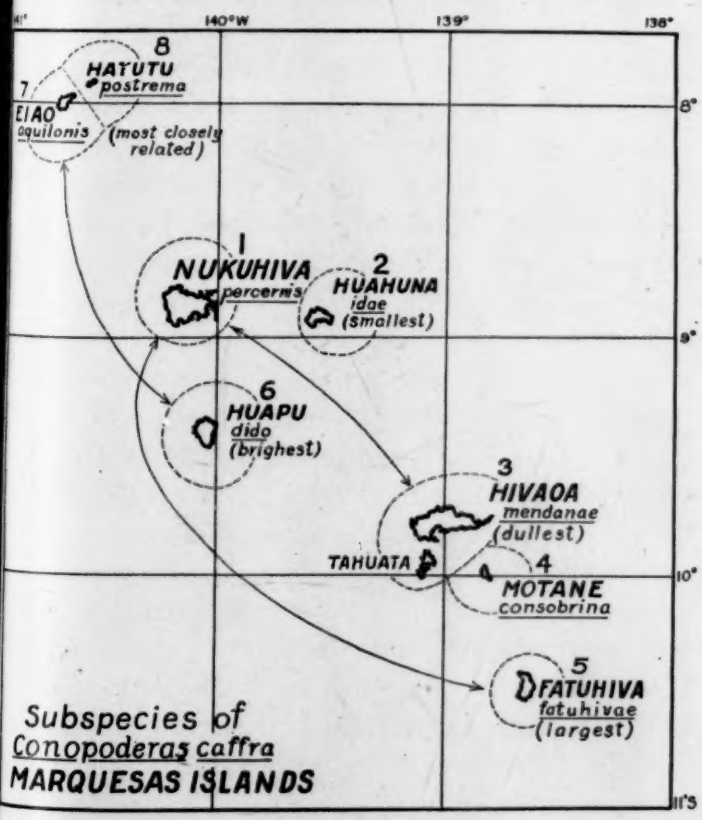

FIG. 1

In Fig. 1 I have allowed the mere subspecific names to stand for the eight warblers, because the birds are of such relatively uniform aspect except as regards the extremes in size that they do not lend themselves well to diagrammatic representation. The three double-headed arrows connecting islands or groups of islands indicate general resemblance or apparent relationship between subspecies, but systematic similarity is not necessarily the same as genetic heritage and no such sequential origin as might be suggested by the arrows can be accepted as established.

The eight Marquesan warblers, when torn from their scattered islands and laid side by side as specimens in a museum tray, comprise a close approximation of what is termed continuous variation. We can all but see intergradation, despite the insular setting: Certainly not one of the races is a notable "saltant," as compared with every other. The slight but constant differences are undoubtedly mutational and, needless to say, they have no conceivable causative relation to the environment. Nevertheless, the several island ranges are of necessity completely discontinuous. The dead birds lend no clue to a genetic interpretation of their characteristics, but surely we have no sound reason for assuming that the blood kinship of these forms is any closer, or their age as taxonomic entities necessarily any less, than that of the far more strikingly different flycatchers which occupy all but one of these same islands. If, as Dobzhansky writes, evolution is a modification of genetic equilibrium, and if mutations are the discontinuous steps in the continuous process of species formation, then the "microgeographic" differences among the warblers are due to different relative gene frequencies which, in such small and discrete populations, would be expected to fluctuate over a wide range of values.[5]

Turning now to the flycatchers (*Pomarea*), the diagrams in Fig. 2 stand for the seven Marquesan forms. Their distribution parallels that of the warblers, except that no flycatcher inhabits the northernmost island (Hatutu). Once again we find that the adjacent land areas of Hivaoa and Tahuata share the same form; that Motane has only a "weak" subspecies, closely resembling that of Hivaoa; that Fatuhiva in this instance also harbors the "strongest" and most distinctive of all these congeneric birds. In short, evidence for the isolation-speciation ratio accumulates.

[5] Theodosius Dobzhansky, "Genetics and the Origin of Species," p. 180, 1937.

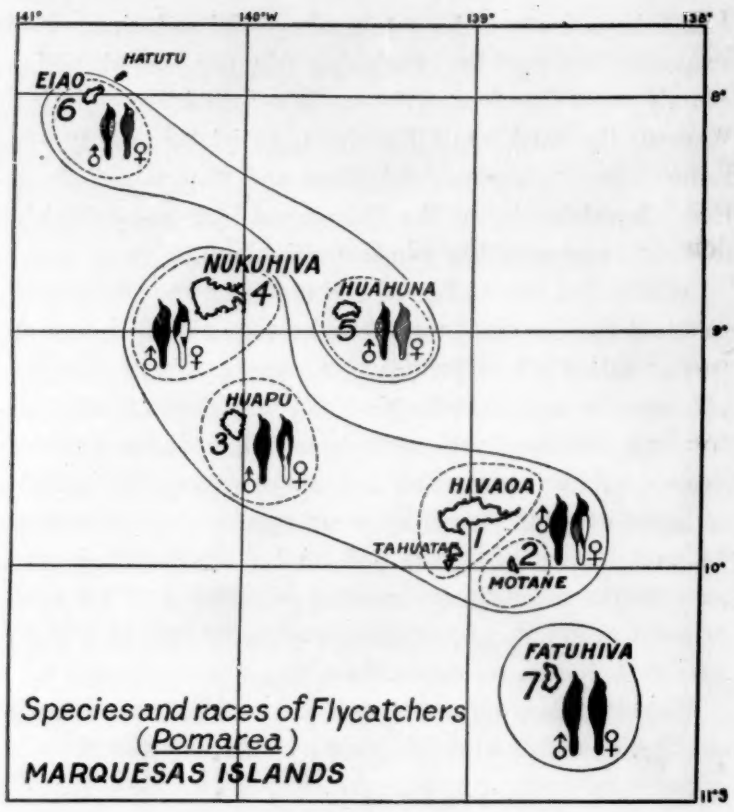

FIG. 2

The flycatchers, because of their marked differences in visible characters, have been described as three species, all endemic at the Marquesas, but they obviously comprise a single Formenkreis. Solid lines in the figure enclose the islands or groups of islands which are the homes of each species, broken lines those of each subspecies, the names of which may be identified from the numbers, as follows: (1) *Pomarea mendozae mendozae;* (2) *Pomarea mendozae motanensis;* (3) *Pomarea mendozae mira;* (4) *Pomarea mendozae nukuhivae;* (5) *Pomarea iphis iphis;* (6) *Pomarea iphis fluxa;* (7) *Pomarea whitneyi.*

In the diagrams of plumage pattern, white represents white, black is black, and ruled lines denote brown. In mature birds of one or the other sex among the seven forms there are therefore instances of an all-brown pattern, of a contrasting black-and-white pattern and of a saturated or all-black pattern. Minor variations include black streaks in the white areas of males belonging to the species *iphis* (5 and 6), and a brown wash on the breast of females in two races of the species *mendozae* (1 and 2). The group as a whole indicates a type of evolution which can hardly be thought of as slow, progressive and continuous. Most emphatically these flycatchers exemplify extreme discontinuity, in sharp contrast with the forms of *Conopoderas.*

Reduced to simplest terms, we find the following combinations of patterns among adult birds from north to south: *P. iphis:* brown or paedogenetic females, pied males; *P. mendozae:* pied females, black males; *P. whitneyi:* black males and females.

The sexes in *whitneyi* are indistinguishable. The species *mendozae,* of which there are four races, is heterogynous in that the subspecific characters appear only in females, the males of all being practically indistinguishable. As between the two species *mendozae* and *iphis,* there has been a partial reversal of secondary sexual characters, the females of the first of these exhibiting a pattern which pertains exclusively to males in the second. Finally, females of the species *iphis* have retained the youthful type of plumage worn by actually immature birds in every one of the seven Marquesan flycatchers, and which, it is not unreasonable to suppose, may typify the primitive or ancestral pattern of the whole assemblage.

Here, then, is something to bite upon, something to serve as a basis for logical interpretation. Within a single closely related group of animals "in the open," we find cock-feathered hens, hen-feathered cocks and immature-feathered hens!

All secondary sexual characters are either sex-linked or sex-limited, that is, the determinant gene lies either in the sex chromosome or in an autosome. In the latter circumstance the gene can express itself only in male or female "soil," as the case may be. Sex-limited characters are a natural result of chemical distinctions between the sexes. The effects of genes should be expected to differ in accordance with the different metabolic rates of male and female.

Thus the variation among these several flycatchers is capable of interpretation in either of two ways, one of which involves sex-linked mutations and the other hormonal control. The latter is more probable, judging by general experimental evidence from birds, but the alternative explanation can not be wholly ruled out as a hypothesis. In females of the species *Pomarea mendozae,* for example, the pied pattern may be either sex-linked in the W chromosome or sex-limited in an autosome. In males of this species the melanistic or saturated pattern may be determined by the Z chromosome and can appear only when two Z's are paired, for among birds, so far as known, it is the male which is homozygous for sex. In the case of *Pomarea whitneyi* we need assume only a familiar type of mutation which makes it possible for the melanistic character to appear when a single Z chromosome is present. We thus arrive at WZ ♀ and ZZ ♂, both black. The condition illustrated by *Pomarea iphis* might be explained by the crossing over of a female character to a male chromosome.

If, on the other hand, pattern determination among the Marquesan flycatchers is similar to that in poultry, male feathering represents the normal species plumage, while the female plumage is the result of inhibitory hormones. The basic condition might then be represented by a pied male and a brown female, as

in 5 and 6 (*iphis*). Ovariectomy would cause such a female to become pied after the next molt.

The last statement is equivalent, however, to saying that influence of the female hormone lowered below a certain threshold would also produce pied females, a condition fulfilled in 1 to 4 (*mendozae*). The black males of *mendozae* could be similarly accounted for by a different hormonal threshold which permitted the pigmentation to go beyond piebald to black. The same situation, combined with a complete lack of female hormonal inhibition, would lead to case 7 (*whitneyi*), in which both sexes are black.

Such explanations are, of course, wholly genetic. Genes frequently act through controlling the rates of reaction; the effect of many mutations, as Goldschmidt[6] has pointed out, is to upset timing during development. A mutant gene may cause a certain "dosage" necessary for normal differentiation to be absent, or present only in a quantity below the necessary threshold. Such facts explain why the appearance of "maleness" in one form may denote "femaleness" in another.

If I seem to have gone into somewhat elaborate detail, it is because these two series of land birds, almost identical in their distribution throughout a small archipelago, present such an extraordinary assortment of the possible results within a limited gamut of biological variation. Furthermore, it should be emphasized that the distinctions within the respective genera represent great apparent differences in degree. The warblers (*Conopoderas*) are birds of common facies, their subspecific characters reflecting the sums of slight mutations which have affected chiefly size and color. The flycatchers (*Pomarea*), on the other hand, not only differ more greatly in size and proportions but also, without losing the clear stamp of common heritage, exhibit startlingly diverse plumage patterns, of both primitive and progressive types, which are, moreover, of the sorts that have been analyzed genetically with laboratory animals.

A population broken up into isolated colonies may differentiate mainly as the result of the restriction of its size. Even if the environment is homogeneous for all colonies, their selection and mutation rates the same and the initial composition identical, a sufficient passage of time will bring about a differentiation which need not be adaptive.[7] These Marquesan flycatchers, known thus far only as they exist in a discontinuous natural environment, do not constitute an altogether adequate genetic demonstration, in the strict sense, but surely the circumstantial evidence they present is too strong to be disregarded.

Islands offer, indeed, the closest approach in nature to the conditions of a man-controlled laboratory. They have one inherent advantage, of course, about which the experimenters can only speculate, namely, the presumably amassed influence of prolonged time. I am aware of no geographic reason as to why the ancestors of the warblers and flycatchers under consideration may not have occupied their respective Marquesan islets for, say, a hundred thousand years. Certainly the principle of complete isolation is often fulfilled at island groups throughout secular periods. The land birds that inhabit them are as a rule extremely sedentary so that transportation or "migration pressure" from one station to another occurs only as a result of exceptional agencies and at very long intervals. The oceans abound in instances of more or less adjacent islands occupied respectively by birds which differ from one another only by characters that might reasonably be ascribed to a single genetic factor. Among certain paired examples, indeed, it is almost obligatory to conclude that one of the two is a homozygote, preserved as such because imprisoned as a pure recessive in its insular "laboratory cage." Color mutants of familiar aspect are plentiful in the guise of endemic island races; flightlessness, comparable in skeletal and feather structure to that exhibited by many breeds of domestic fowl, has arisen among island birds of several orders where the absence of enemies lifts the penalty from such a trend; so-called "adaptive" radiation in the structure, and consequently the function (!), of a single organ, such as the bill, may almost parallel in families of island birds the monstrous mutations of bottle-grown fruit-flies. This is exemplified *par excellence* among the strange Hawaiian honey-creepers (Drepanididae) which have run their own complicated evolutionary course so long, and so far removed from the rest of the world, that the clues to their real phyletic affinities have become almost hopelessly obscured. To cite another somewhat comparable family of insular birds, it should be recalled that the famous "finches" of the Galápagos (Geospizidae) were perhaps the strongest particular influence in implanting the germ of the evolutionary idea in the mind of the youthful Darwin, who was impressed by the perfect gradation in the size of the beaks among the species of these curious birds.

III

I accept, in the main, the orthodox tenets regarding the processes of heritable variation which, after the all-important ingredient of *time* has been added, no doubt weave the infinite pattern of speciation in nature. So far as we certainly know, all inherited differences have arisen as mutations, and the example of the Marquesan flycatchers might serve to reconcile the points of view of the taxonomist and the student of genetics. Nevertheless, I want to indicate one or two remarkable cor-

[6] Richard Goldschmidt, "Physiological Genetics," 1938.
[7] Dobzhansky, *op. cit.*, p. 183.

relations frequently illustrated among island birds, in the attempt to account for which, so far as I am aware, neither an adequate genetic hypothesis nor a speculation as to the possible effect of the environment has ever been advanced.

One of these concerns the presence of some particular structural stamp shared by a more than chance proportion of island birds, regardless of their systematic affinities. The other relates to common or nearly universal characteristics that we sometimes encounter in practically all the forms of birds confined to a particular island. At Ninigo, northwest of the Admiralty group, Dr. Mayr has found that every one of a considerable number of endemic subspecies is larger and of darker coloration than the nearest related forms elsewhere. At Rennell, an outlier of the Solomons, the endemic subspecies show a pronounced tendency toward reduction in size; in fact, this island is the sole home of the smallest known races of many species of birds which are widely distributed throughout the Indo-Australian region. These facts can hardly be dismissed as coincidences. It is well known that representatives of various families, orders and even classes inhabiting a given geographical region often undergo convergent changes, for which specific biophysical reasons have been advanced.[8] But neither the adaptive "peaks" and "valleys" of Wright,[9] nor any mechanism independent of the environment appear to explain why mutations toward small size make the components of a varied population fittest to survive at Rennell.

Turning now to the question posed first above, it has long been recognized that island land birds are apt to have longer or more robust bills than their nearest continental representatives. Fortunately, the fourth edition of the "Check-List of North American Birds," together with the exhaustive collections of the American Museum of Natural History, have given me an opportunity to test this tradition statistically for one continent throughout the entire order of Passeres. The results are listed in Tables I and II. Among 27 subspecies of insular larks, jays, wrens, kinglets, shrikes, vireos and finches, covering a zonal range between the Arctic and the Tropics along both coasts of North America, 78 per cent. prove to have larger bills than their mainland representatives. When subspecies have developed into species—if that be, in truth, the actual procedure of evolution—this strange distinction becomes even more marked and we find that *every* North American insular species has a larger bill than its nearest continental kin. For the present, such a problem bids fair to stump geneticists and "environmentalists" alike!

[8] Cf. Dobzhansky, *op. cit.*, p. 165.

[9] Sewall Wright, 1932. *Proc. 6th Internat. Congr.* Genetics, Vol. 1, pp. 356–366.

TABLE I

Twenty-one subspecies of North American passerine birds breeding exclusively on islands, as listed in the A. O. U. Check-List, 1931, which have relatively larger bills than their nearest mainland representative races:

Subspecies	*Breeding Range*
Nannus hiemalis meligerus	Aleutian Is.
" " *kiskensis*	" "
" " *alascensis*	Pribilof Is.
" " *tanagensis*	Aleutian Is.
" " *petrophilus*	" "
" " *semidiensis*	Semidi Is.
" " *helleri*	Kodiak I.
Thryomanes bewicki nesophilus	Santa Cruz and Santa Rosa Is.
Thryomanes bewicki catalinae	Santa Catalina Is.
Thryomanes bewicki leucophrys	San Clemente I.
Salpinctes obsoletus guadeloupensis	Guadalupe I.
Corthylio calendula obscurus	" "
Vireo griseus maynardi	Florida Keys
Carpodacus mexicanus clementis	Is. off California and L. C.
Pinicola enucleator carlottae	Queen Charlotte Is.
Pipilo maculatus clementae	San Clemente and Santa Catalina Is.
Passerculus sandwichensis sandwichensis	Aleutian Is.
Aimophila ruficeps obscura	Is. off California
Passerella iliaca insularis	Kodiak I.
Melospiza melodia graminea	Santa Barbara I.
" " *clementae*	Is. off California

The remaining six island races in the same list, which do not have relatively larger bills than their closest mainland representatives:

Subspecies	*Breeding Range*
Otocoris alpestris insularis	Santa Barbara I.
Cyanocitta stelleri carlottae	Queen Charlotte Is.
Lanius ludovicianus anthonyi	Santa Barbara I.
Vireo griseus bermudianus	Bermuda
Melospiza melodia micronyx	San Miguel I.
" " *coronatorum*	Los Coronados Is.

77.8 per cent. of all the North American insular races are large-billed.

TABLE II

The 9 species of North American passerine birds breeding exclusively on islands, and properly comparable with continental forms, which have relatively larger bills than their nearest mainland representative species:

Species	*Breeding Range*
Progne cryptoleuca	Cuba
Aphelocoma insularis	Santa Cruz I.
Thryomanes brevicauda	Guadalupe I.
Compsothlypis graysoni	Socorro I.
Carpodacus mcgregori	San Benito I.
Carpodacus amplus	Guadalupe I.
Pipilo consobrinus	Guadalupe I.
Passerculus princeps	Sable I.
Junco insularis	Guadalupe I.

No exceptions: 100 per cent. of the island species have larger bills than their closest mainland relatives.

IV

Well, even if you freely admit the fascination and importance of problems in island ornithology, you may still reply, "Why the hurry? The world is overflowing with material for evolutionary research, and our grandchildren can take up these far-away matters after we ourselves have solved a greater proportion of the unknown that still lies within arm's reach."

But that hope is exactly what will not be capable of realization. The oceanic island work, at least, must be done soon or never. Islands comprise the most delicate and evanescent of environments for their

native biotic communities as soon as civilized man and his satellites put in an appearance and proceed to upset the ancient balance. The list of organisms that have become extinct within the historic period fairly bulges with the names of astonishing island birds, from the dodo of Mauritius to the mamo of Hawaii. All the peculiar land birds of Tristan da Cunha Island, in the South Atlantic, have become extirpated since the introduction of hogs and rats. The remnant of the fauna of Tahiti is waging a rapidly losing struggle against domestic mammals, alien hawks, mynahs and weavers that have become established there, and against the wild-fire spread of lantana and other weeds that have already dispossessed much of the original vegetation. The same story is being repeated elsewhere; primitive conditions that may have flourished for a million years melt away when men of the dominant races, whether white or yellow, arrive to break the spell.

Experimentalists are understandably impatient of data beyond reach of their breeding tests. But we should remember that the present age of experiment will some day be combined with an age of fuller correlation, when the inconceivably rich mine of factual matter now buried in the text of ten thousand outdated books will be drawn upon, and when zoological collections, no less than zoological literature, will be combed for now ignored truths that can then be properly fitted into the picture of life as a whole. We museum men collect and preserve not only with respect to our individual scientific predilections; rather, we may be said to share some of the characteristics of devoted librarians. We feel a heavy responsibility to lay up, while opportunity offers, a capital sum of the irreplaceable data of science, even though part of this fortune may not begin to bear interest at its proper rate for a long while to come.[10]

SCIENTIFIC EVENTS

RESEARCH GRANTS OF THE VIRGINIA ACADEMY OF SCIENCE

THE Research Committee of the Virginia Academy of Science met on November 5 to make the regular awards for the encouragement of scientific research in Virginia. It had available for distribution $450, which included the $100 from the American Association for the Advancement of Science. It had in hand sixteen applications for grants amounting to $1,200. After long and careful consideration of each request the following awards were finally made:

To Professor James I. Clower, of the Virginia Polytechnic Institute, $50 provided the Virginia Polytechnic Institute would supply an equal amount for the purchase of a Robinson colorimeter for use in his study of lubricating oils in automobiles.

To Dr. J. Frank Hall and Dr. R. L. Simpson, of the Medical College of Virginia, $50 to be used in the purchase of animals and other supplies in their study of the changes in the abutment teeth and their surrounding tissues brought about by the additional stress applied through crown and bridge restorations.

To Dr. C. W. Lampson and Dr. A. I. Whitenfish, of the University of Richmond, $60 provided the University of Richmond would supply a similar amount needed for the purchase of a special condenser needed in their study of the dielectric constant as a factor in the "salting out" of non-electrolytes.

To Dr. M. J. Murray and Dr. F. F. Cleveland, of Lynchburg College, $97.50 to be used for the purchase of apparatus and supplies needed in their study of the Raman effect and molecular structure.

To Dr. A. A. Pegau, of the University of Virginia, $50 to help to defray the expenses in mapping an unmapped portion of the Petersburg granite, chiefly in Dinwiddie County.

To L. B. Snoddy, of the University of Virginia, $90 to help to defray expenses in the study of the luminous discharge in the aurora borealis as a function of time.

To M. A. Stirewalt and F. F. Ferguson, of the University of Virginia, $50 to help to defray their expenses in a study of the occurrence, distribution, taxonomy and physiology of the Turbellaria of the eastern United States.

Dr. J. Shelton Horsley, Sr., reported that the amount of the research fund had now been brought up to $13,000, and consequently the amount available for distribution next year should be correspondingly larger.

E. C. L. MILLER,
Secretary

CONGRESS OF AMERICAN INDUSTRY OF THE NATIONAL ASSOCIATION OF MANUFACTURERS

A THREE-DAY Congress of American Industry opened in New York City on December 7. At this meeting the report was presented of the joint committee of leading industrialists and scientific men that was established last year to study increasing production and employment through wider use of scientific research in industry. A considerable part of the session held on December 8 was devoted to it. The chairman of the committee is M. H. Eisenhart, president of the Bausch and Lomb Optical Company, Rochester, N. Y.

The activities to be undertaken by the committee with relation to industrial research include:

[10] The author wishes to express his appreciation of the privilege of discussing the genetic aspects of this paper with Dr. G. K. Noble and with Professors T. H. Morgan and Richard Goldschmidt.

Encouragement of wider use of scientifically trained men in industry.

A survey to determine advantages to smaller industries of maintaining research laboratories.

Promotion of cooperative research activities generally.

Study of advantages of cooperative technical research by industrial groups.

Encouragement of educational institutions to train men who can organize and carry on industrial research programs, especially in small factories.

In the field of "pure research"—research which does not necessarily have a commercial aim—the Joint Committee plans:

To study the importance of pure research to the public generally, and the problem of its adequate financing.

To analyze and express, in the business man's language, the objectives and industrial possibilities inherent in the long-term trends of present-day pure research.

To promote the employment of scientists in industry for the purpose of interpreting the trends and results of pure research and visualizing possibilities of applications to specific industries.

The speakers at a session on "Research, an Increased Asset for National Progress," were: Dr. Willard H. Dow, president of the Dow Chemical Company, Midland, Mich., representing management; Dr. Carl Breer, of the Chrysler Corporation, New York, representing industrial laboratories, and Dr. Isaiah Bowman, president of the Johns Hopkins University, representing independent laboratories.

Members of the Joint Committee include the following scientific men: Dr. Karl T. Compton, president of the Massachusetts Institute of Technology; Dr. George B. Pegram, dean of the Graduate School, Columbia University; Dr. R. A. Millikan, chairman of the Executive Council of the California Institute of Technology; Dr. Ross G. Harrison, chairman of the National Research Council; Dr. F. R. Moulton, permanent secretary of the American Association for the Advancement of Science; Dr. E. R. Weidlein, director of the Mellon Institute; Dr. Henry A. Barton, director of the American Institute of Physics, and Julius Weinberger, of the Radio Corporation of America.

Industrialists who are members of the committee are: W. B. Bell, president of the American Cyanamid Company, New York; J. C. Hilton, vice-president, Standard Oil Company of New Jersey, New York; J. F. Lincoln, president of the Lincoln Electric Company, Cleveland, Ohio; John F. Tinsley, president, Crompton and Knowles Loom Works, Worcester, and Philip C. Wentworth, treasurer, National Ring Traveler Company, Providence.

AWARD OF THE ROEBLING MEDAL OF THE MINERALOGICAL SOCIETY OF AMERICA TO DR. SCHALLER

AT its annual luncheon, to be held on December 28 in the Waldorf-Astoria Hotel in New York City in connection with the annual meeting of the Mineralogical Society of America, from December 28 to 30, the society will present the Roebling Medal to Dr. Waldemar Theodore Schaller, of the U. S. Geological Survey. Professor Esper S. Larsen, professor of petrography at Harvard University and former associate of Dr. Schaller on the U. S. Geological Survey, will make the presentation. The Roebling Medal was authorized by the Mineralogical Society in 1936. The medal is awarded for "Meritorious Achievement in Mineralogy and Allied Sciences." It has been named in honor of the late Colonel Washington A. Roebling, or Trenton, N. J. Colonel Roebling was by profession an engineer and, in connection with his father, John A. Roebling, constructed many famous bridges throughout the country. However, his chief interest, outside of his profession, was mineralogy and he maintained an intense delight in it throughout his life. He built up one of the most complete private collections in the United States and was so well acquainted with his specimens that although he collected some 16,000 different mineral specimens he was able to identify and describe them on occasion. His interest was not limited to the mere collection of rare specimens, but included the recent literature regarding them, and he often furnished specimens for research and analysis. His collection now forms part of the famous mineral display at the U. S. National Museum.

Dr. Waldemar Theodore Schaller, the second recipient of the Roebling Medal, was born in Oakland, Calif., and attended the University of California, from which he received a bachelor of science degree in 1903. Since that time he has been chemist and geologist with the U. S. Geological Survey, and this year will mark his thirty-fifth anniversary of service. In 1912, Dr. Schaller received his Ph.D. from the University of Munich. Dr. Schaller is a charter fellow of the Mineralogical Society of America, was its president in 1926 and since 1931 has been treasurer. He is a fellow of the Geological Society of America, the American Academy of Arts and Sciences, the Washington Academy of Sciences, honorary member of the New York Mineralogical Society, member of the American Chemical Society, American Institute of Mining and Metallurgical Engineers and of the British, French, German and Austrian mineralogical societies.

In his mineralogical work, Dr. Schaller has published about 150 papers and reports dealing with mineralogy and has described more than 40 new mineral species. Among these is the mineral, kernite, the most important borax mineral found in the United States. Much of his work has also been devoted to the mineralogy of the potash fields of New Mexico and Texas. Dr. Schaller is one of the leading authorities in the world on rare and unusual minerals. One of his most interesting contributions has been a study of the crys-

tal cavities in the trap rock region of the Watchung Mountains of New Jersey. Dr. Schaller has also made a particular study of the interesting and beautiful minerals of pegmatites and their mode of origin.

PAUL F. KERR,
Secretary

MEDALS OF THE AMERICAN GEOGRAPHICAL SOCIETY FOR 1938

THE Charles P. Daly Gold Medal for 1938 of the American Geographical Society of New York has been awarded to Dr. Alexander Forbes, professor of physiology in the Harvard Medical School.

Early in 1931, largely at the suggestion of Sir Wilfred Grenfell, Dr. Forbes undertook a geographical survey in northern Labrador, and expeditions to that region were made under his leadership in 1931 and 1935 and under his direction in 1932. Dr. Forbes saw the possibilities in a new method of surveying from the air that was being developed by the American Geographical Society. Through his expeditions the opportunity was offered the society of thoroughly testing the method in the field and of demonstrating its practicability, and as a consequence, the northernmost end of the Labrador peninsula, previously almost wholly unknown, has been accurately mapped.

Louise A. Boyd, explorer and geographer, who returned on November 30 from her sixth expedition to the Arctic, has been awarded the Cullum Gold Medal for 1938 in recognition of her achievement in Arctic geographical research. She is the second woman to receive one of the awards of the society.

According to the official announcement made public by the society, Miss Boyd is the only woman to achieve an outstanding position in Arctic exploration. This past summer she penetrated the berg-infested waters off the coast of Greenland to a point further north than had been reached by ship by any other American, and to within thirty miles of the northernmost latitude (78 degrees 16 minutes N., 16 degrees 21 minutes W.) reached by the Duc d'Orléans in 1905. With her were a scientific staff consisting of a surveyor, a geologist, a hydrographer and a radio operator to carry on research on short wave transmission. This was her fourth expedition conducted under the auspices of the American Geographical Society.

Among other explorers who have received the Cullum medal in the past are: Peary, Nansen, Scott, the Duke of the Abruzzi, Shackleton, Prince Albert of Monaco and Bertram Thomas.

RECENT DEATHS AND MEMORIALS

DR. WILLIAM MCDOUGALL, since 1927 professor of psychology at Duke University and from 1920 to 1927 professor of psychology at Harvard University, previously reader in mental philosophy at the University of Oxford and a fellow of Corpus Christi College, died on November 28 at the age of sixty-seven years.

DR. ALCAN HIRSCH, president of the Hirsch Laboratories, New York, and consulting chemical engineer, died on November 24 at the age of fifty-three years.

DR. DAVID ROBERT COKER, a plant breeder and cotton expert, died on November 28 at the age of sixty-eight years. Dr. Coker was the originator of staple cotton varieties. He was a trustee of the University of South Carolina.

M. GEORGES URBAIN, French chemist, died on November 5 at the age of sixty-six years. He was a professor at the Institute of Biology in Paris and for several years professor of theoretical chemistry and chairman of the section of chemistry of the School of Advanced Study at the University of Paris.

Nature reports the death of Dr. P. A. Murphy, professor of plant pathology in the Albert Agricultural College, University College, Dublin, on September 27, aged fifty-one years, and of Paul Helbronner, the geodesist, "free member" of the Paris Academy of Sciences, on October 18, aged sixty-seven years.

THE fortieth anniversary of the discovery of radium and the seventy-first anniversary of the birth of Madame Curie were commemorated on November 6 in New York by Polish-Americans and representatives of Poland and France, under the auspices of the New York State Conference of Polish Clubs and the United St. Stanislaus Societies. Dr. Francis Carter Wood, director of the Crocker Cancer Research Institute of Columbia University, made the principal address.

THE British Society of Chemical Industry celebrated on November 24 the centenary of Sir William Perkin, the discoverer in 1856 of the first aniline dyestuff, mauve.

SCIENTIFIC NOTES AND NEWS

A DINNER in celebration of the fiftieth anniversary of the founding of the department of biology at Western Reserve University and the fifty years of service there of Dr. Francis H. Herrick, now professor emeritus of biology, was held on December 3. President Winfred G. Leutner served as toastmaster. Dr. E. G. Conklin, executive vice-president of the American Philosophical Society and professor emeritus of biology at Princeton University, gave the principal address.

THE seventieth birthday of Dr. Thomas S. Cullen, retiring professor of gynecology of the Medical School of the Johns Hopkins University, was celebrated at a dinner given in Baltimore on November 19. Harry Nice, formerly governor of Maryland; Phillips Lee Goldsborough and Mayor Jackson were among the speakers. Other speakers were: Dr. Howard A. Kelly; Dr. J. M. T. Finney; Dr. Abraham Flexner, director of the Institute for Advanced Study at Princeton; and Dr. Isaiah Bowman, president of the Johns Hopkins University. A portrait of Dr. Cullen, by the late Thomas Corner, was presented by Mrs. Cullen. It was accepted by Dr. Bowman and will be hung in the women's clinic.

DR. E. V. MCCOLLUM, professor of biochemistry and head of the department of biochemistry of the school of hygiene and public health of the Johns Hopkins University, was the guest of honor at an anniversary dinner of the National Dairy Council held in Chicago on November 30. Dr. McCollum, who was introduced by Dr. Morris Fishbein, editor of the *Journal* of the American Medical Association, gave an address on his work on nutrition.

THE Chemists' Club, New York, gave on December 2 a testimonial dinner in honor of Dr. Leo Hendrik Baekeland, honorary professor of chemical engineering at Columbia University and president of the Bakelite Corporation. At this dinner honorary membership in The Chemists' Club was conferred upon him. Dr. Baekeland is known for his invention of Velox photography and the discovery of Bakelite resinoid.

DR. F. R. MOULTON, permanent secretary of the American Association for the Advancement of Science, was the guest of honor at a dinner given at Richmond on November 25 by the Virginia Section of the American Chemical Society. After the dinner Dr. Moulton delivered an address entitled "Celestial Chemistry and Engineering."

SIR RICHARD GREGORY arrived in New York on December 1. He will deliver on December 9 the Elihu Root lecture of the Carnegie Institution on "Cultural Contacts of Science." He will give an address before a general session of the American Association for the Advancement of Science at Richmond on December 29, and will be the principal speaker at a dinner of the National Association of Science Writers on December 26. Before sailing for the United States a dinner was given in honor of Sir Richard at the Athenaeum Club, London, to mark his retirement as the editor of *Nature*.

DR. HENRY C. CHRISTENSEN, of Chicago, secretary of the National Association of Boards of Pharmacy, received the Remington Medal of the New York Branch of the American Pharmaceutical Association at a dinner given in his honor on November 30 at the Hotel Pennsylvania. The award was presented by Dr. Henry V. Arny, dean emeritus of the School of Pharmacy of Columbia University. The speakers were: Robert Swain, deputy commissioner of health for Maryland; E. F. Kelly, secretary of the American Pharmaceutical Association, and J. Leon Lascoff, president of the association.

MISS ALICE EASTWOOD, for the past forty-six years curator of botany in the California Academy of Sciences, turned the first shovelful of earth in the ground-breaking exercises for the Floricultural Building at the Golden Gate International Exposition on November 26. John McLaren, superintendent of Golden Gate Park since 1887, and Miss Kate O. Sessions, horticulturalist of San Diego, were also honored in the ground-breaking exercises, over which Professor Sydney B. Mitchell, of the University of California, presided.

THE Albers-Schönberg Medal of the German Röntgen Society has been conferred on Dr. Hans Holfelder, professor of general clinical roentgenology at Frankfort-on-Main.

DR. MALCOLM GOODRIDGE, formerly professor of clinical medicine at Cornell University Medical College, was elected president of the New York Academy of Medicine for a two-year term at the annual meeting held on December 1. He succeeds Dr. James Alexander Miller. Dr. Rufus Cole, who retired last year as director of the Hospital of the Rockefeller Institute for Medical Research, was elected vice-president for a three-year term. Dr. Bernard Sachs, neurologist and a former president of the academy, was chosen treasurer for three years; Dr. Miller and Dr. Charles F. Tenney were elected trustees for five years; Dr. Carl G. Burdick was elected a trustee to fill the unexpired term of the late Dr. Frederick Tilney.

ASSISTANT PROFESSOR AUGUSTUS SISK, of the University of Tennessee, has been elected head of the department of mathematics and physics at Maryville College, Tennessee.

DR. BENJAMIN KROPP has resigned as instructor in anatomy and research fellow in obstetrics at the Harvard Medical School, to become lecturer in embryology at Queen's University Medical School, Kingston, Ontario.

DR. HERBERT SHAPIRO, formerly of Princeton University, has been appointed research associate in general physiology at Clark University.

OFFICERS of the Engineers' Council for Professional Development, of which the constituent societies are the American Society of Civil Engineers; the American

Institute of Mining and Metallurgical Engineers; the American Society of Mechanical Engineers; the American Institute of Electrical Engineers; the American Institute of Chemical Engineers; the Society for the Promotion of Engineering Education and the National Council of State Boards of Engineering Examiners, have been elected for the year 1938–1939 as follows: *Chairman,* J. P. H. Perry, vice-president of the Turner Construction Company, New York City; *Vice-chairman,* R. E. Doherty, president of the Carnegie Institute of Technology, Pittsburgh; *Secretary,* S. L. Tyler, secretary of the American Institute of Chemical Engineers, New York City; *Assistant secretary,* C. E. Davies, secretary of the American Society of Mechanical Engineers, New York City. The United Engineering Trustees, Incorporated, will continue to act as treasurer.

JAMES G. OSBORNE has been appointed chief of the Section of Forest Measurements, U. S. Forest Service. He succeeds F. X. Schumacher, who resigned some time ago to accept a professorship in the Graduate School of Forestry at Duke University.

STANFORD UNIVERSITY SCHOOL of Medicine announces the award of a grant by the Committee on Scientific Research of the American Medical Association to the department of surgery, to be used by Dr. Frederick A. Fender in the development of a device for direct electrical stimulation. The committee has extended to Dr. Irving J. Wolman, of the department of pediatrics of the University of Pennsylvania, a renewal of the grant for experimental studies on Lipoid Pneumonia.

DR. RUTH M. ADDOMS, assistant professor of botany at Duke University, who has been granted sabbatical leave for the second semester of the current year, will spend several months at the University of Leeds, in the laboratory of Professor J. H. Priestley.

DR. EUGENE F. DU BOIS, professor of medicine at Cornell University Medical College, will deliver the third Harvey Society Lecture of the current series at the New York Academy of Medicine on December 15. Dr. Du Bois will speak on "Heat Loss from the Human Body."

DR. HENRY G. KNIGHT, chief of the Bureau of Chemistry and Soils of the U. S. Department of Agriculture, gave a lecture before the New York University Chapter of Sigma Xi on November 17. He spoke on "The Role of Minor Elements in Agriculture."

DR. J. SHOHAT, professor of mathematics at the University of Pennsylvania, will give at the Graduate School in the U. S. Department of Agriculture, beginning late in January, a series of six lectures on interpolation and mechanical quadrature.

DR. RAYMOND L. DITMARS, curator of reptiles of the New York Zoological Park, gave a lecture illustrated with moving pictures on November 28, the opening night of the annual arts and sciences week at the University of Missouri. The lecture was entitled "Our Animal Friends and Foes."

SIR WILLIAM BRAGG, president of the Royal Society, delivered an address on "The Advance of Science" at the Ely Diocesan Conference, which was held at Cambridge on November 21.

THE fourteenth annual Norman Lockyer Lecture was given in London under the auspices of the British Association on December 6 by Dr. H. Spencer Jones, astronomer royal. The subject of the lecture was "The Atmospheres of the Planets."

THE New York Academy of Sciences and affiliated societies will hold their annual dinner and meeting at the Hotel Astor, New York City, on the evening of December 14. There will be lectures by Dr. Victor K. LaMer, professor of chemistry at Columbia University, and by Dr. Roy Waldo Miner, curator of living invertebrates at the American Museum of Natural History.

A JOINT meeting of the Pasteur Society of Central California and the California Academy of Sciences commemorating the centenary of the cell theory was held on November 10 in San Francisco. Following a dinner at the Western Women's Club, addresses were given as follows: "The Development of the Cell Theory," by Dr. F. M. MacFarland, president of the academy; "The Influence of the Cell Theory," by Dr. Robert C. Miller, director of the academy's museum and Steinhart Aquarium; "The Chemical Architecture of the Cell," by Dr. Chauncey D. Leake, professor of pharmacology in the University of California Medical School. Dr. Charles Edward Smith, president of the Pasteur Society, presided.

THE subsection on pharmacy of the Section on the Medical Sciences of the American Association for the Advancement of Science has organized a symposium on glycols for the meeting in Richmond. The program, which will be presented on Tuesday, December 27, is as follows: (1) The Chemistry of Glycols, Dr. Frank C. Whitmore, president of the American Chemical Society; (2) The Pharmacology of the Glycols, Dr. H. O. Calvery, chief of the Division of Pharmacology, Food and Drug Administration, U. S. Department of Agriculture; (3) The Industrial Applications of the Glycols, H. B. McClure, Carbide and Carbon Chemicals Corporation; (4) The Pharmaceutical Uses of the Glycols, Dr. A. G. Du Mez, dean of the School of Pharmacy, University of Maryland, editor of *Pharmaceutical Abstracts.* Discussion will be opened

by Dr. H. B. Haag, professor of pharmacology of the Medical College of Virginia, and Dr. M. G. Mulinos, of the College of Physicians and Surgeons, Columbia University.

THE National Council of Teachers of Mathematics will hold on December 29 and 30 its fifth annual meeting at Williamsburg, Va. The general subject of the meeting will be "Mathematics that Functions." There will be a joint dinner with the Mathematical Association of America and the American Mathematical Society on December 29. The council will meet in three sections as follows: Arithmetic Section, Secondary Mathematics Section and Teacher Training Section.

THE Medical College of Virginia, Richmond, celebrated Founders' Day marking the one hundred first anniversary of its founding on Thursday, December 1. Virginius Dabney, editor of the *Richmond Times-Dispatch,* spoke on "Medicine in a Changing World." The exercises were preceded by an academic procession of visitors, faculty and members of the student body.

AN aerial survey of an hour's duration of the geology of the New York region, sponsored by the Geological Society of America, is planned for Saturday morning, December 31, at the semi-centennial meeting of the society, which will be held in New York City from December 28 to 30. The trip will be led by Dr. Girard Wheeler. The group will start from the Newark airport and fly up the Hudson River past the Palisades, then northward to see the escarpment at the edge of the highlands. The plane will then swing southeast over Long Island Sound, where there have been changes resulting from the recent hurricane. After viewing the Long Island shoreline the return will be made to the Newark airport by way of Staten Island.

WESTERN RESERVE UNIVERSITY has received as a legacy from the late Mary Frances Morris, who died on August 2, a business building at 500 Prospect Avenue, in Cleveland. The yearly income, amounting to $2,000, is to be used for scholarships for young women in Flora Stone Mather College.

THE MEYERSTEIN INSTITUTE OF RADIOTHERAPY at the Middlesex Hospital, for the treatment of cancer by radium and x-rays, was recently opened by Sir William Bragg, president of the Royal Society. Its erection was made possible by a gift of $230,000 from Sir Edward Meyerstein. All forms of radiotherapy are available both for the in-patients and out-patients of the hospital and for private patients.

AS has already been reported in SCIENCE, David Cleghorn Thomson, formerly secretary to the Oxford University Appeal Committee, has been appointed general secretary, in succession to Mr. Walter Adams, of the Society for the Protection of Science and Learning (formerly known as the Academic Assistance Council) which for five years has been handling the academic side of the international refugee problem. *Nature* states that Cleghorn Thomson is a graduate of the Universities of Edinburgh and Oxford; a senior history exhibitioner of Balliol, he was for seven years the B.B.C.'s chief official in Scotland. The Society for the Protection of Science and Learning, of which the Archbishop of York recently became president in succession to the late Lord Rutherford, acts as a central bureau of information regarding professors, lecturers and research workers displaced in their own country on account of "race," religious or political opinions, and aids in securing the continuation of their valuable work in other countries. So far, of the 1,350 displaced scholars registered with this society, 520 have been permanently placed in thirty-eight countries, apart from more than 300 who have temporarily found work. Within the last three months, the society has received 340 applications from scholars who have had to discontinue academic activity in Austria. The offices of the society are at 6 Gordon Square, London, W.C.1.

THE senate of the University of London invites applications for the university chair of medicine, tenable at University College Hospital Medical School, with a salary of £2,000 a year. Applications (twelve copies) must be received not later than January 16 by the Academic Registrar, University of London, Senate House, W.C.1, from whom further particulars can be obtained.

DISCUSSION

PHOTOSYNTHESIS AND THE LIVING STATE

IT is hardly necessary to remark that no new definition of "The Living State" is contemplated. For the purposes of these remarks we may assume that the living state is associated with the heterogeneous but organized substance called protoplasm, and that such criteria as growth, reproduction, respiration and photosynthesis will be sufficient identification.

Hans Molisch[1] was perhaps the first investigator to announce that the evolution of oxygen from green plant cells was possible when the organism was no longer alive. He also attributed this important reac-

[1] H. Molisch, *Zeits. Bot.,* 17: 577, 1925.

tion to an enzyme. The data which led him to these conclusions were the fact that he could dry leaves for a few days at temperatures not above 30 degrees Centigrade and they would still evolve oxygen when moistened and illuminated.

In repeating Molisch's work it was found that the results could be confirmed readily with some plants but not with others. It was also found that if the plant leaves were ground with the proper buffers and then dried there was loss of the power to evolve oxygen. Luminous bacteria were used by both Molisch and the author to test for the release of free oxygen.

In undertaking further experiments along this line several methods of inhibiting the evolution of oxygen by irradiated organisms containing chlorophyll have been tried.

Nitella sp. cells were cut and the contents squeezed out and immediately tested for the evolution of oxygen. The results indicate that a positive test can be found if there is only a few minutes' delay between the time the cell contents are extruded and the test for the evolution of oxygen. The cell contents of *Valonia macrophysa*,[2] mixed with luminous bacteria, remained capable of evolving oxygen for two hours after cell disorganization. These cells were about one centimeter in diameter and even the evolution of oxygen from a single cell could be easily detected.

Press juice obtained by placing lawn clover (*Trifolium repens*) under high pressure evolved oxygen readily. Microscopic examination showed that no cells were present.

The reactions of *Euglena viridis* to low temperatures were the basis for the most of the present work. The *Euglena* cultures were grown in diffuse or artificial light at room temperatures.

When *Euglena* is kept at −4 degrees Centigrade for four hours and then brought back to room temperature (about 20 degrees Centigrade) the microscopic appearance indicates some plasmolysis and a tendency for the cells to become spherical. The evolution of oxygen is very weak and sometimes negative, apparently depending on the state of the culture used. At −40 degrees Centigrade for 20 minutes, with about one hour at room temperature to recover, there is generally evolution of oxygen when tests are made immediately. In fact, some cultures were frozen eight hours at −40 degrees Centigrade and tests for the evolution of oxygen made at once were positive. In all cases where freezing was at −40 degrees Centigrade for six hours the evolution of oxygen was only a temporary matter and the cultures would no longer grow in nutrient media. Tests for the absorption of carbon dioxide in a closed tube using phenolsulfonephthalein as an indicator were negative after four hours' freezing at −4 degrees Centigrade or one hour at −40 degrees Centigrade. Many experiments demonstrated that when both the absorption of carbon dioxide and the evolution of oxygen were negative the cultures would no longer grow. In many cases there was evidence that no carbon dioxide absorption was taking place in light, even though there was a temporary evolution of oxygen by the culture.

Euglena, Spirogyra and moss leaves showed much variability to freezing, and subsequent tests for the evolution of oxygen seemed to show that in some organisms there was a storage of some substance which would evolve oxygen for a short period of time, even though cells were absent or were so injured that they did not recover. One is reminded of the storage of luciferin-luciferase by *Cypridina* so that the protein enzyme complex can be extracted and perform its reaction of evolving light *in vitro,* but the inability to do the same with luminous bacteria. The explanation usually given for this observation is that the luminous bacteria do not store the luciferin-luciferase system, while *Cypridina* does.

These experiments tend to support the assumption that the evolution of oxygen is an enzyme reaction depending on radiation and not necessarily on the living cell except for the formation of the substance. This is further confirmed by the fact that hundreds of tests made on cell contents have shown that once the power to evolve oxygen is depleted in cell-free material, there is never any recovery. This would probably mean that there is a good chance that the complex responsible for the evolution of oxygen upon irradiation may be isolated, but it does not help much in looking forward to the understanding of how the living cell builds the oxygen-evolving substance.

It seems clear that we may conclude that the cells of some green plants may be disorganized and killed and yet retain for a short time some of their power to evolve oxygen upon irradiation. It is, however, very doubtful whether the absorption of carbon dioxide takes place so that a regular photosynthetic cycle is set up in such triturates. This points to the fact that there is, after all, a close relationship existing between the whole mechanism of photosynthesis and the organized living green plant cell.

O. L. INMAN

C. F. KETTERING FOUNDATION FOR THE STUDY OF CHLOROPHYLL AND PHOTOSYNTHESIS, ANTIOCH COLLEGE

[2] These *Valonia* cells were supplied by Dr. W. J. V. Osterhout, of the Rockefeller Institute, New York City.

A SULFOXIDE OF METHIONINE

OWING to the biological interest attached to the sulfur-containing amino acid methionine any of its oxidation products are of potential significance. When a solution of dl-methionine perchlorate in isopropyl alcohol is allowed to react with an excess of hydrogen peroxide the amount of oxygen consumed upon com-

pletion of the reaction corresponds to one atom per molecule of methionine. Neutralization of the perchloric acid with amylamine causes a precipitate that consists, according to analysis and properties, of practically pure methionine sulfoxide in a yield of over 90 per cent. The amorphous precipitate can be converted into the form of microcrystalline aggregates by careful precipitation by acetone from aqueous or aqueous-methanolic solution. The product decomposes at 220–230° and appears to be more soluble than any of the natural amino acids: 1 gram dissolves in about 1.5 cc of water, while about 30 cc are required by the parent substance dl-methionine. The solubility in methanol seems similarly increased. The acidity of an aqueous solution is that of a typical neutral amino acid (pH about 4.5). The compound does not oxidize iodide under the conditions which cause complete deoxygenation of cystine disulfoxide,[1] but concentrated (57 per cent.) hydriodic acid liberates almost instantaneously the expected amount of iodine.

This product, which has not been isolated previously, although it has been discussed,[2] is of interest (a) chemically, because it should consist of a mixture of equal parts of four stereoisomeric structures as the molecule contains, in addition to the "asymmetric" carbon atom, an "asymmetric" sulfur atom; (b) technically, on account of its high solubility which might be utilized in the isolation of the natural l-methionine; and (c) biologically, in connection with Hammett's[3] theory[4] on the role of intermediate oxides of sulfur in the control of cell division. Separation of the four isomers seems desirable and should also be of interest in relation with the problems of the metabolic decomposition of methionine.

G. TOENNIES

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COMMENTS ON THE SHAPE, GROWTH AND QUALITY OF THE AMERICAN OYSTER

LUNZ[1] gave data showing that oyster shells from Indian shell heaps are larger than present-day oysters from South Carolina commercial beds and stated that small size of the latter is probably due to intensive commercial oystering, which prevents maximum growth. He stated that the evident quality of pre-colonial oysters far surpassed those of to-day. The situation is more complex than the short treatment indicated.

Unfortunately, there was a misstatement about the percentages by which the pre-colonial oysters exceeded present oysters in size. Ordinary pre-colonial oysters were said to be 62.23 per cent. longer and 76.89 per cent. wider than modern oysters. The correct figures are 60.67 and 42.61, respectively, according to the data.

Oysters take various shapes imposed on them by contact with their fellows or other solid materials, but there are two general shapes. On hard bottom with sufficient room oysters grow almost as wide as long and in rare instances wider. The long axis of growth curves to the right. Illustrative of this type are wild oysters of Karankawa Bay, Texas, mentioned by Galtsoff.[2] Round oysters have heavy shells with both valves cupped. They have a large adductor muscle, are usually fat, have a high gallon yield per barrel of shell stock and shrink little due to loss of fluid after being opened, so that they are always in demand by the trade.

Where oysters are crowded or growing on soft bottom and slowly sinking the shell grows straight, upright and very long. The shell is thin, much longer than wide, the bottom (left) valve alone is troughed, the adductor muscle grows rapidly forward and smaller in proportion to the size of the animal than in round oysters. These oysters are known as snappers or coons. Galtsoff and Luce[3] discussed conditions which produce them and stated that in "old times" coon oysters existed in Long Island Sound and Connecticut, with the unstated inference that these have given way to the rounder cultivated type.

Coon oysters from Coon Island, Matagorda Bay, culled for market size by an oysterman, were selected for straightness and the top valve length and width measured with a vernier caliper. The small culls were also measured. Oysters from Wells Point, Matagorda Bay, selected for market size and roundness, were measured. Measurements of unattached seed oysters from the same locality, unselected, although they were of the round type, were on hand. These data were compared with those of Lunz (changed to centimeters for comparison) in the table. Measurements of the lower valve from hinge to bill, as made by Lunz, are slightly shorter than the upper valve.

Examination of the length/width ratios show that selected oysters from Indian shell heaps were "coons," as were selected oysters from South Carolina commercial beds. Likewise, average oysters from shell piles were nearer the coon type than average oysters from

1 *Jour. Biol. Chem.*, 113: 583, 1936.
2 *Biochem. Jour.*, 22: 1417, 1928, and 26: 2041, 1932.
3 *Protoplasma*, 11: 382, 1930.
4 In its application to neoplasia a new confirmation of this theory, by sulfur oxides of the sulfanilamide type (*Biochem. Jour.*, 32, 1207, 1938, has just been added to an earlier confirmation by cystine disulfoxide (*Am. Jour. Cancer*, 26: 554, 1936).
1 G. Robert Lunz, Jr., SCIENCE, 87: 367, 1938.
2 P. S. Galtsoff, Bur. Fish. Invest. Rep. No. 6, 1–30, 1931.
3 P. S. Galtsoff and R. H. Luce, Bur. Fish. Doc. 1077: 61–100, 1930.

TABLE I

MEASUREMENTS IN CENTIMETERS AND LENGTH/WIDTH RATIOS OF OYSTERS FROM MATAGORDA BAY, TEXAS, COMPARED WITH DATA OF LUNZ[1]

Type of oyster	Number	Average length	Average width	L/W ratio
Small round	200	3.57	3.08	1.16
Market size round.....	112	9.48	7.58	1.25
Small coons	139	7.63	3.81	2.00
Market coons	153	11.74	5.07	2.32
South Carolina Oysters				
Selected shells, Indian shell heaps	10	16.61	6.50	2.56
Selected oysters, S. C. commercial beds..	140	9.93	4.90	2.03
Ordinary shells, Indian shell heaps	50	10.90	6.38	1.71
Ordinary oysters, S. C. commercial beds..	150	6.78	4.47	1.52

commercial beds. Oysters in the latter category averaged only 2.67 inches in length. The quality must have been poor, for minimum legal market size in most Southern states is 3 or 3½ inches.

Both sets of data show that the length/width ratio increases with size for both round and long oysters, but the increase is greater for the elongate type.

Coon oysters often grow in shallow water and are taken by hand so much that wading for oysters is known in some localities as cooning. This oyster was more easily obtained by the American Indian than the round oyster from deeper water. It seems plausible that small populations of Indians had the choice of larger oysters than those coming from intensively fished wild reefs of certain localities to-day. However, well-cultivated beds and some wild beds produce oysters comparable in size, although shorter in length, to any the Indian was able to obtain.

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THE FERMENTATION TEST FOR VITAMIN B_1

IN October of 1937 there appeared in SCIENCE a short note by R. J. Williams[1] on the use of yeast or other fungi for vitamin B_1 tests. In it Dr. Williams coupled our fermentation test[2, 3, 4] with Schopfer's growth test. Reference to the original note on our fermentation test[2] will show that the test is in no way related to growth and, in fact, test conditions tend to exclude growth of the yeast.

No attempt was made, at the time, to correct the impression created by Williams's note because it was thought that the reader would readily detect the error. However, in a recent book on vitamin B_1 by R. R. Williams and Spies[5] these authors have repeated the remarks referred to above.

It is to be hoped that by calling attention to the above inaccuracies in the literature, a more correct appraisal of the fermentation test will be made possible. This useful and rapid method for the determination of vitamin B_1 has been successfully employed in our laboratories for several years.

ALFRED S. SCHULTZ
LAWRENCE ATKIN
CHARLES N. FREY

THE FLEISCHMANN LABORATORIES,
STANDARD BRANDS, INC.,
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APPEAL FOR AID FROM CZECHO-SLOVAKIA

IN a letter of October 31 from Professor K. Absolon, curator of the Moravian Museum, Brno, Czecho-Slovakia, the writer appeals for aid with subscribers to the monthly *Příroda* (Nature), which as a result of the recent crisis has lost many local subscriptions and is thereby endangered in its existence. Professor Absolon asks that this matter be brought to the attention of the American libraries and establishments, as well as workers in natural history. The periodical in question has now reached thirty-one volumes. Its contents resemble those of *Popular Science Monthly,* with many original scientific reports and observations. All the original contributions, especially for the future, are and will continue to be provided with translations of their titles and text of illustrations, as well as with an adequate summary in English, French, German or Italian. The yearly subscription price of the periodical for America is $3.00.

A. HRDLIČKA

U. S. NATIONAL MUSEUM

SCIENTIFIC BOOKS

ANIMAL PARASITOLOGY

Traité de zoologie et de parasitologie médicale et vétérinaire. By M. NEVEU-LEMAIRE, professeur agrégé des facultés de médecine, Paris. Published by Vigot Frères, éditeurs.

IT is just fifty years since the appearance of the great treatises of Blanchard on human parasites and of Neumann and Railliet on those of domestic animals which gave to scientific students reference works of comprehensive character for the rapidly expanding

[1] R. J. Williams, SCIENCE, 86: 349, 1937.
[2] A. S. Schultz, L. Atkin and C. N. Frey, *Jour. Amer. Chem. Soc.*, 59: 948, 1937.
[3] *Ibid.*, 59: 2457, 1937.
[4] *Ibid.*, 60: 1514, 1938.
[5] R. R. Williams and T. D. Spies, "Vitamin B_1 and Its Use in Medicine," Macmillan, 1938.

field of animal parasitology. In this half century the knowledge of the structure and activities of these organisms and an understanding of their significance in human welfare have been largely increased by active students of the field. Many general publications covering various aspects of the subject have been contributed by workers in all countries, but it has been left for Neveu-Lemaire to solve the difficult problem of bringing together all the work accomplished and of including it without serious loss in a single treatise, which should give a successful picture of the entire field.

Of this monographic undertaking, which is to comprise three volumes—helminthology, entomology and protozoology—the first and second have already appeared and the third is approaching completion. The volume on helminthology contained 1,544 pages and was illustrated by 787 figures. The volume on entomology, which has just come from the press, has 1,376 pages and 597 figures. Both volumes are worked out on the same plan. The first section is devoted to a consideration of general topics in that field, starting with a historical sketch and including thereafter discussions of degree of parasitism, origin of the parasitic habit, details of life history and mode of attack as evolved by various types of parasites, responses of the host to parasitic invasion and other biological problems involved in the varying interrelations of the organisms.

The second section treats of the anatomical and taxonomic features of the various genera and species of the parasites of man and the domestic animals. The geographic distribution of these forms has been well worked out and emphasis laid on their pathogenic rôle in parasitic diseases which has been shown to be highly significant through the investigations especially of the last forty years. This section is well organized, complete and up-to-date, and naturally it occupies the major part of each volume. An extended discussion of hosts and the different taxonomic groups of free living animals which give shelter and sustenance to particular parasites brings together in lists, tables and condensed forms a mass of valuable material not otherwise easily available to students in parasitology.

The illustrations are reasonably numerous, in large part new, and so far as checked also rightly credited to their original sources. The volumes are well printed and provided with good indexes. As the result of detailed checking of the data given in various sections of these volumes, the reviewer has been impressed with the breadth and accuracy shown. This work justly ranks as the most comprehensive treatise of recent date in this field. Work done in all European and extra-European laboratories has been carefully brought together and due credit given to foreign authors, thus escaping the criticism of national overemphasis charged against some writers. The text manifests that clarity and effectiveness in style generally characteristic of French publications. The treatise is a most valuable addition to the literature of parasitology.

HENRY B. WARD

SOLAR RADIATION

Etude Practique des Rayonnements Solaire, Atmospherique et Terrestre (Methodes et Resultats). By CH. MAURAIN. Paris, 1937.

THIS is a very comprehensive summary of our present knowledge on the important subject of the character, the intensity and the duration of solar radiation. It covers 188 octavo pages, is divided into 14 chapters, contains 38 tables of data and is illustrated by 18 text figures.

The author points out the close relation between the intensity of solar radiation and related problems of interest to mankind, such as climatology, the thermodynamics of the atmosphere and forecasting the weather.

He also refers to the difficulties encountered in attempting to obtain measurements of the degree of accuracy necessary to obtain comparisons between the intensities of similar elements at different points on the surface of the earth, as is done in forecasting the weather. For example, in order to exclude all sky radiation from measurements of the intensity of direct solar radiation, it has been found necessary to cover the outer end of the long tube, or vestibule, of the pyrheliometer with a thin glass cover, which must be kept free from dust. A long vestibule requires a driving clock of considerable power and accuracy. It has been found that at Blue Hill, the ratio between the readings of the Smithsonian silver disk pyrheliometer and the Eppley pyrheliometer, which records automatically on a Wheatstone bridge, does not vary from 0.400 by more than ± 0.001, provided all adjustments are accurately made and maintained.

In Chapter V, Table V, are summarized monthly means of atmospheric transmission for stations varying in latitude from 2° south to 51° north, and from altitude 8 m to 3,492 m above sea level, for each season of the year. The greatest monthly variation is shown at Turin, 66 per cent. in September to 79 per cent. in February and April. The least variation is shown at Calama, Chile, from 79 per cent. in January to 84 per cent. in August and September. The latter location was selected by the Smithsonian Institution for one of its stations for determining the value of

the solar constant of radiation, on account of the small amount of variation from month to month in the atmospheric coefficient of transmission.

Linke adopted the factor

$$T = \frac{\text{Total atmospheric depletion}}{\text{Depletion by pure dry air}}.$$

This factor becomes large in industrial cities, as is shown in the more equable climate of urban than of suburban regions.

Chapter VI treats of the total radiation received on a horizontal surface, directly from the sun and diffusely from the sky, and also from cloud sheets, either transmitted or reflected. This is an important subject, and Ångstrom's treatment of it is given in detail.

In this chapter, "Global radiation" is defined as the total radiation received from the sun, either directly, or diffusely from the sky; and in Fig. 11 are shown typical records, obtained on a day with sunshine, and also on cloudy days.

In chapter VII the radiation from the earth to the sky is considered, which is easily measured during the night hours, but which is taking place at all hours of both day and night, although under certain conditions of cloudiness its intensity becomes very low, or even negative in direction, when a cold surface is covered by warm clouds.

The seven chapters reviewed treat of the subject under consideration from the statistical standpoint. The remaining chapters consider it from the theoretical standpoint, which is quite apart from the treatment here reviewed.

HERBERT H. KIMBALL

VITAMIN B_1 AND ITS USE IN MEDICINE

Vitamin B_1 and Its Use in Medicine. By ROBERT R. WILLIAMS and TOM DOUGLAS SPIES. The Macmillan Company Monographs. The Macmillan Company, 1938.

DEFICIENCY of vitamin B_1 (thiamin) is the cause of beriberi, which, since the dawn of medical history, has been one of the major health problems, as it is to-day, in populations subsisting largely upon polished rice. There is increasing evidence that deficiency of this nutrient occurs in the United States to a degree which impairs the health of a considerable number of people. It is, therefore, one of the most interesting of the food factors which are essential in the diet. Since its existence was first demonstrated by Eijkman, in 1897, thiamin has been investigated by many investigators. The greatest achievement in this field of research was the improvement of the yield of the vitamin by Dr. Williams from rice polishings, so that about an ounce of crystalline material was made available for chemical study. With this material, Dr. Williams and his associates succeeded in determining the structure of the molecule and in following up this knowledge in an astonishingly short time by its synthesis. The synthetic vitamin has now become available at moderate cost in any quantities which may be necessary for the prevention of beriberi and for clinical use.

In Part I of the book, "Vitamin B_1 and Its Use in Medicine," the authors have discussed in a concise way all aspects of thiamin deficiency which may be instructive to medically trained readers, and suggest the clinical conditions in which thiamin deficiency may be suspected. Every clinician should be familiar with the recorded experience with thiamin in therapy, and many will gain by reading this excellent discussion suggestions which they will want to apply in their practice.

Part II is devoted to the fascinating story of the researches which have yielded our present knowledge of the vitamin, its physiological role and its final synthesis.

This book should be read by every biochemist, physiologist and progressive physician. The reader may be assured that he will be entertained and instructed by it.

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SPECIAL ARTICLES

A FATAL DISEASE OF PIGEONS CAUSED BY THE VIRUS OF THE EASTERN VARIETY OF EQUINE ENCEPHALOMYELITIS

DURING the recent epidemic of equine encephalomyelitis in southeastern Massachusetts, a number of human cases of encephalitis were observed, which were shown by Fothergill, Dingle, Farber and Connerley[1] and by Webster and Wright[2] to have been due to the virus of the Eastern variety of equine encephalomyelitis. As part of our investigation of the human disease, it became of importance to consider the possibility of other host reservoirs of the virus. We were informed by a number of pigeon breeders residing in the area where the horse disease existed that during the period of the equine epidemic they had suffered unusual losses in their flocks both of special breeding stock and of the common, domestic pigeon, the species so numerous in our cities. Indeed, one of these breeders made the interesting observation to us by letter that his "losses of pigeons began to cease as soon as the cold weather set in."

[1] L. D. Fothergill, J. H. Dingle, S. Farber and M. L. Connerley, *New Eng. Jour. Med.*, 219: 411, 1938.

[2] L. T. Webster and F. H. Wright, SCIENCE, 88: 305, 1938.

We received a dead pigeon on September 20, 1938, from a breeder whose residence was adjacent to a farm on which two horses had died of the equine disease. The brain was removed, triturated in sterile sea sand, and suspended in 10.0 cc of infusion broth. After centrifugation, part of the supernatant liquid was filtered through a Berkefeld V filter. Young albino Swiss mice were injected intracerebrally with both filtered and unfiltered material (four animals in each group). All these mice died in 48 to 96 hours, having exhibited symptoms similar to those observed in mice infected with the equine virus of the Eastern variety. Bacteriological cultures of the pigeon brain suspension before injection and of the brains of the dead mice were sterile. Subsequent experiments confirmed the filterability of the infectious agent.

The identification of the pigeon virus was determined by intracerebral injection of guinea pigs previously immunized[3] against the Eastern and the Western varieties of virus, and in normal controls. Each animal received a dose of 0.15 cc of a 1:1000 dilution of mouse-brain passage virus. Of six guinea pigs immunized against the Eastern virus, two died, and from one of these we were unable to isolate the virus; the other four remained well and showed no symptoms. Two animals immunized against the Western virus and all six controls died. From one of the guinea pigs previously immunized with the Western virus, and from two of the controls, the virus was again recovered in mice. We conclude from this experiment that the virus isolated from the pigeon was the virus of the Eastern variety of equine encephalomyelitis.

Pigeons were shown to be susceptible to the virus obtained directly from the original pigeon, following intracerebral inoculation. In other experiments, pigeons were shown to be susceptible to the strain of the Eastern variety of equine virus isolated from the brain tissue of the human case elsewhere described.

Giltner and Shahan[4] first demonstrated the susceptibility of pigeons to experimental inoculation of equine encephalomyelitis virus (probably Western type). These authors and, later, Ten Broeck, Hurst and Traub,[5] suggested the possibility of pigeons as host reservoirs of the virus. The susceptibility of a number of species of birds to experimental inoculation of the virus was demonstrated by Remlinger and Bailly.[6] We have been unable to find any report of the isolation of this virus from pigeons dying from natural infection by it.

Summary: The virus of the Eastern variety of equine encephalomyelitis has been recovered from the brain of a pigeon[7] which had spontaneously contracted the disease in an area where equine encephalomyelitis was prevalent among horses.

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THE DEMONSTRATION OF PHAGE PRECURSOR IN THE BACTERIAL CELL[1]

IN their original study of the kinetics of the phage-bacterium reaction, Krueger and Northrop[2] found bacterial growth to be the essential conditioning factor for phage production. Under the conditions of their experiments any interference with bacterial growth was accompanied by a corresponding reduction in phage formation as stated in the equation:

$$\frac{P}{P_o} = \left(\frac{B}{B_o}\right)^n$$

where P = [phage] at any time, P_o = initial [phage], B = [bacteria] at any time and B_o = initial [bacteria].

More recently Krueger and Baldwin[3] have reported experimental evidence for the production of phage according to the reaction: phage precursor + phage→ phage. The precursor, apparently a normal cell metabolite, was obtained in ultrafiltrates of growing phage-susceptible cell suspensions. The essential reaction then is analogous to the autocatalytic transformation of inactive enzyme precursor into active enzyme upon the addition of small amounts of the active form to a solution of the precursor, *e.g.*, trypsinogen + trypsin→trypsin. The detection of phage precursor led to the conclusion that precursor formation, rather than bacterial growth as such, should condition phage production and that the apparent role of bacterial growth is due to the fact that both these expressions of cellular metabolism have nearly identical optimal milieus.

[3] We are indebted to Dr. R. W. G. Wyckoff and to Lt. Col. Raymond A. Kelser for providing some of the immune guinea pigs. Others were immunized by ourselves with chick-membrane vaccine kindly furnished by the Lederle Laboratories.

[4] L. T. Giltner and M. S. Shahan, SCIENCE, 78: 63, 1933.

[5] C. Ten Broeck, E. W. Hurst and E. Traub, *Jour. Exp. Med.*, 62: 677, 1935.

[6] P. Remlinger and J. Bailly, *Compt. rend. Soc. de Biol.*, 121: 146, 1936; *ibid.*, 122: 518; *ibid.*, 123: 562.

[7] Our findings in pigeons were briefly mentioned, with our permission, by Dr. Roy Feemster in an address before the American Public Health Association meeting in Kansas City, on October 26, and will be published in the *American Journal of Public Health*. They were likewise referred to by one of us (L.D.F.) in an address before a meeting of the the New England Veterinary Association in Boston, on October 26.

[1] The experimental work cited has been supported by grants-in-aid from the American Medical Association, the Research Corporation of New York and from various interested friends.

[2] A. P. Krueger and J. H. Northrop, *Jour. Gen. Physiol.*, 14: 223, 1930.

[3] A. P. Krueger and D. M. Baldwin, *Proc. Soc. Exp. Biol. and Med.*, 37: 393–395, 1937.

Experimentally Krueger and Fong[4] found it possible, by adjusting the pH and temperature of phage-bacteria mixtures, to completely inhibit bacterial reproduction, while phage formation continued. There is some question as to the theoretical significance of these results, however, inasmuch as the method employed for detecting Δ [bacteria] was not highly sensitive. Because of this and also because the yields of phage precursor have been both limited and irregular, we have sought a means of studying the precursor-phage reaction in the cell. The accumulated data offer excellent evidence for the existence of phage precursor within the bacterium and likewise for the dissociation of phage production and cell growth.

To demonstrate intracellular phage precursor we prepare "activated" suspensions of staphylococci by growing the organisms in a highly oxygenated medium. The activation process requires some two hours, after which the cells are separated from the medium, resuspended in Locke's solution and maintained at 5° C. for two hours in order to rule out the possibility of bacterial growth during subsequent reactions with phage. To demonstrate the precursor, 4 ml of activated cell suspension containing 5×10^8 bacteria/ml is added to 1 ml of phage diluted with Locke's solution to contain 1×10^9 activity units/ml. The initial phage concentration of the mixture, therefore, is 2×10^8 activity units/ml. The mixture is kept for five minutes at 5° C. and is then promptly titrated for total phage content. The end titre is found to be 2×10^9 phage units/ml, whereas that of a control (non-activated bacteria prepared from a 16-hour agar culture) is 2×10^8 units/ml.

A detailed study of the reaction occurring when phage is added to activated bacteria will be reported elsewhere. The data indicate that:

(*a*) Phage precursor is produced by the actively metabolizing bacterium and apparently is present on the cell surface.

(*b*) Precursor production is enhanced by conditions which favor general cell metabolism. Cell growth and phage formation as a consequence present a pseudo-relationship, for both are dependent upon similar environmental factors. The activation process mentioned above merely serves to induce the production of relatively large amounts of precursor before the cells are put into a resting state by storage in Locke's solution at 5° C.

(*c*) Precursor is transformed into phage within two to four minutes after the addition of phage to activated cell suspensions. The precursor content of activated cells is maintained for a period of 6 to 24 hours.

(*d*) Phage precursor is more thermolabile than the bacterial cell. It is possible to destroy the precursor content of the cell by heat and still keep the cell alive.

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[4] A. P. Krueger and Jacob Fong, *Jour. Gen. Physiol.*, 21: 137–150, 1937.

THE HYDROLYSIS OF STEROL GLYCOSIDES BY EMULSION

IT has been shown by Odell and Marrian[1] that pregnanediol, as well as other sterol sex hormones, occurs in the urine conjugated with glycuronic acid.

A majority of the methods so far employed for the isolation or estimation of sex hormones depend upon acid or alkali hydrolysis of the glycosidal linkage.[1, 2] While most investigators feel that the sterol sex hormones are not destroyed to any appreciable extent by such treatment, proof that such is the case is inconclusive.

Venning[3] has proposed a method for the isolation of pregnanediol (as sodium pregnanediol glycuronate) by which she has determined the pregnanediol content of human pregnancy urine (eighth month) to be from 20 to 25 milligrams per liter of urine (equivalent to from 40 to 60 milligrams of pregnanediol glycuronate). Other investigators have reported findings of the same order of magnitude.

Since it has been suggested that pregnanediol glycuronate might be a beta glycoside,[3] it occurred to the authors that hydrolysis of the glycuronate might be effected rapidly, and without destruction of pregnanediol, by the enzyme emulsin.

Preliminary experiments have shown that pregnanediol glycuronate is hydrolyzed rapidly by low concentrations of emulsin at a pH of approximately 6.0, the hydrolysis being carried out directly in the urine. This may be considered proof that pregnanediol glycuronate is a beta glycoside. Isolation of the pregnanediol freed by this method and extracted from the urine by a modification of the original process of Katzman and Doisy[4] yields a product of high purity without additional purification (m.p. 235° C. uncorr.). Treated in this manner, second to eighth month human pregnancy urine yields from 40 to 50 milligrams of pure crystalline pregnanediol per liter; or approximately twice the amount previously reported by other investigators.

Full details of this investigation will appear soon in the literature.

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[1] Odell and Marrian, *Biochem. Jour.*, 30: 9, 1936.
[2] Marker, *Jour. Amer. Chem. Soc.*, 60: 2442, 1938.
[3] Venning, *Proc. Soc. of Exp. Biol. and Med.*, 34: 792, 1936.
[4] Katzman and Doisy, *Jour. Biochem.*, 98: 739, 1932.

AN EFFECT OF LIPID FEEDING UPON VITAMIN C EXCRETION BY THE RAT[1,2]

DURING the past year we have been searching for the biological precursor of vitamin C (ascorbic acid) by a technique that has given clear-cut and consistent results —that is, the results are clearly positive or negative in each case. The earlier published suggestions that mannose and certain other substances might serve as precursors of ascorbic acid could not be verified in our own or other laboratories during the past six years. Meanwhile, identification of the vitamin as a single substance and the development of sensitive, quantitative methods of analysis have led to a greater appreciation of the vitamin's probable wide-spread importance in cellular processes. It is now evident that ascorbic acid can be synthesized by practically all plants and animals, with the exception of guinea pigs, man and the other primates. Therefore, even though only the latter types are subject to scurvy, it is reasonable to assume that the vitamin has definite, essential functions in all the higher plants and animals (the lower, or less highly organized types, have not been investigated extensively). From a chemical point of view the role of the vitamin *in vivo* is essentially unknown, even though many empirical physiological relationships are clearly recognized.

The technique that we have used is essentially as follows. Young or adult albino rats are kept in raised-bottom cages of the usual type, below which a fine screen and funnel serve to collect the urine into small vials. The vials contain enough metaphosphoric acid to provide a final concentration of approximately 3 per cent. The samples are removed and titrated once each day to provide a measure of vitamin excretion. Animals fed a stock diet of Purina chow or Sherman's diet No. 13 show a sharp drop in vitamin C excretion during inanition, or a more gradual drop when placed on a diet of condensed milk. Hence, after a short period of inanition (3 to 4 days) and an additional period (generally 3 to 6 days) on condensed milk, they are in a suitable condition for assay purposes. The animals are then fed the test supplement plus a basal diet of condensed milk.

The common purified foodstuffs such as sugars, proteins and oils do not affect the rate of vitamin C excretion. Oats, oat oil, the unsaponifiable matter from oat oil and halibut liver oil quickly induce a high rate of excretion that may readily exceed 2 mg per day. Comparable results with respect to the time and extent of response are obtained by feeding the pure vitamin. Certain volatile fractions from liver oil and oat oil are especially active, and investigations are being continued for the purpose of checking the identity and structural relationships of the active materials from different sources. The fatty acids and common sterols are inactive.

The results are of interest, not only in relation to the biological synthesis of a vitamin, but also because of the novel effect of a lipid upon the synthesis of a carbohydrate (the vitamin, $C_6H_8O_6$, is essentially a sugar). Although the suggestion of this type of lipid-to-carbohydrate conversion has apparently never been made, there is considerable evidence in the literature to indicate that vitamin C is peculiarly related to the mitochondrial, adreno-cortical and carotenoid lipids.

It is possible that the lipid effect may be exerted through an indirect agency, such as by accelerating a synthesis from other substances, or by serving as a protective agent against tissue destruction. These phases of the problem are being investigated, but the weight of evidence at the present time favors the "precursor" interpretation.

The vitamin excretion has been verified by biological assays with guinea pigs, in addition to chemical titrations, so that there is no question concerning the identity or approximate quantity of the product excreted.

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ROBERT H. TULLY, III
HERBERT E. LONGENECKER
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[1] Research Publication No. 371, from the Department of Chemistry, University of Pittsburgh.

[2] This investigation was made possible by a research grant from the Buhl Foundation.

PLANT VIRUS INHIBITORS PRODUCED BY MICROORGANISMS

IN a recent paper from this laboratory[1] it was shown that many bacteria and fungi were capable of inactivating the virus of ordinary tobacco mosaic, and that the time required for this action depended upon the organism used. It was also suggested at the time that the inactivation of the virus in the cultures was due to decomposition or digestion. The high comparative rate of inactivation of the virus by certain organisms such as *Aerobacter aerogenes* (Kruse) Bergey *et al.* and *Aspergillus niger* Van Tiegham stimulated further investigation of their behavior. It soon became evident that these organisms differed from most microorganisms with respect to type of inactivation in that they were capable of producing a substance (or substances) in culture which when added to an extract of tobacco mosaic is immediately inhibitory to the infectivity of the virus. This substance is not toxic to living matter in the usual sense when used on bacterial, fungal or higher plant cultures, and in this respect, resembles charcoal, Phytolacca juice,[2] dry soil and trypsin, in its action on the virus. Whether or not the substance

[1] J. Johnson and I. A. Hoggan, *Phytopath.*, 27: 1014-1027, 1937.

[2] B. M. Duggar and J. K. Armstrong, *Ann. Mo. Bot. Garden*, 12: 359–366, 1925.

is to be regarded as a virus inactivator or an inhibitor to host infection as reported by Stanley for trypsin[3] has not been fully determined. Since the inhibitory effects on infectivity is instantaneous it suggests that the inactivation of the virus in the instance of the two above organisms grown in culture can not be attributed to decomposition or digestion. Efforts at precipitation and purification have not been successful. The substance may be concentrated appreciably by evaporation of the culture medium, the inactivator being tolerant to drying and to heat, partly withstanding 100° C. for several hours. In a dried broth culture the product is normally active at 0.1 per cent. water solution and retains most of its activity at 0.01 per cent. concentration. A normal concentration will completely inactivate an equal volume of undiluted extract of ordinary tobacco mosaic. It is equally effective on several other plant viruses. The inactivator passes bacterial proof filters but with considerable reduction in potency. The substance retains its activity for months in either the original culture, a heat-sterilized culture or in a state of desiccation. It will also withstand high concentrations of alcohol, chloroform, mercuric chloride and charcoal. The substance differs strikingly from the Phytolacca juice and trypsin inhibitors in several respects, as for example in its ability to tolerate higher temperatures. There is therefore probably no chemical relationship between these peculiar virus inhibitors.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE USE OF PLASTIC MATERIALS FOR OPERATIONS ON AMPHIBIAN EMBRYOS

OPERATIONS on amphibian embryos are usually carried out in black wax dishes, while grafts are held in place by means of glass rod "bridges."[1] When these devices are employed for transplantation experiments on the hind limb of Amblystoma,[2] however, it is usually difficult to hold the embryos firmly since the wax can not be molded about them *in situ;* nor is it always possible to adjust the glass bridges to the proper contact and pressure for good healing.

The following materials and devices have been developed[3] to provide more adequate equipment for operations on Amblystoma embryos. They have been used successfully, with minor improvements, for five seasons and have been found adaptable to a wide variety of experiments with both anurans[4] and urodeles.

A. OPERATING DISHES

Various types of waxes and modeling clays have been tested to find a non-toxic material which can be molded readily and into which pins can be inserted easily and firmly. Most waxes are unsuitable for these purposes, although colorless "Rainbow Wax" (American Art Clay Company) works easily but lacks the firmness of clays. Stone[5] also reports satisfactory results from molding white refined beeswax. On the other hand, almost all clay modeling materials can be molded readily under the solution used for operating and are sufficiently firm, but many of them are toxic, especially those with noticeable odor or color.

To date, uncolored or gray Permoplast Modeling Clay (made of China clay, petrolatum and glycerine—American Art Clay Company, Indianapolis, Ind.) has been found most satisfactory for retaining the embryos without injury and for holding the graft covers securely during the progress of healing.

The operating dish is made by filling a Stender preparation dish of 50 or 60 mm diameter about half full of the modeling material. In performing the operation a depression is made in the plastic material by means of a blunt glass stylus, while the embryo lies alongside for comparison of size and shape. The embryo is then inserted into the cavity and the material pressed around it, or tiny spurs rolled up over it by means of a spear-shaped needle or glass rod. When the embryo is ready to be removed, it may be freed without injury by pushing or scooping away the surrounding material.

B. GRAFT COVERS

Graft covers with pin supports have been devised to hold the transplanted tissue in place during healing. The cover proper is made of some clear transparent plastic sheet material such as du Pont's Lucite, Plastacele or Pyralin of .090 inch to .125 inch thickness. The pin supports are fashioned from small gold-plated safety pins (Fig. 1, A) or large (No. 7) non-corrosive insect pins. The safety pins are preferable, however, since the clasps form convenient "handles."

The graft covers are made by sawing a piece of the sheeting into small rectangular blocks of about $\frac{1}{8}$ inch x $\frac{3}{8}$ inch each. A fine hole is then drilled through each end of the block, using a No. 70 or 71 wire gauge drill,

[3] W. M. Stanley, *Phytopath.*, 24: 1055–1085, 1934.
[1] R. G. Harrison, *Jour. Exp. Zool.*, 32: 6, 1921.
[2] W. A. Stultz, *Jour. Exp. Zool.*, 72: 330, 1936.
[3] W. A. Stultz, *Anat. Rec.*, 64: Suppl. no. 1, 43, 1935.
[4] K. A. Youngstrom, *Jour. Comp. Neur.*, 68: 353, 1938.
[5] L. S. Stone, *Proc. Soc. Exp. Biol. and Med.*, 31: 1084, 1934.

depending on the diameter of the pin. The edges of the block are then smoothed with a sharp blade, but care should be taken not to mar the upper and lower surfaces where clear visibility is necessary. The block may also be trimmed away to form a surface of contact of any shape or size desired.

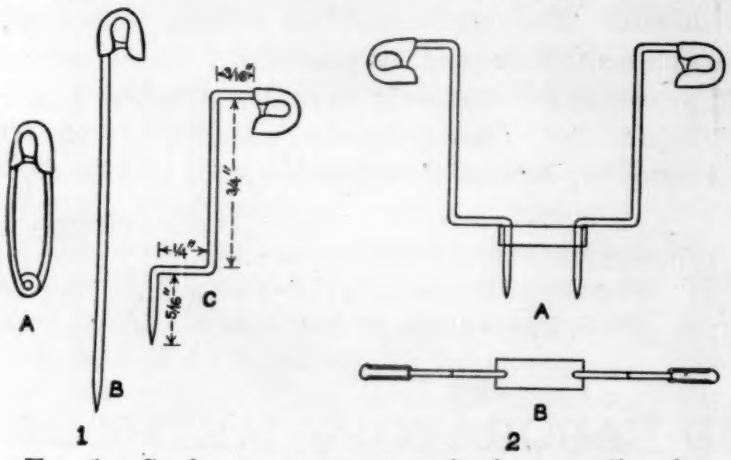

FIG. 1. Graft cover support made from small safety pin (A) straightened out (B) and bent at three points (C). ×1.

FIG. 2. Completed graft cover viewed from the side (A) and from above (B). ×1.

The supports are made by first straightening out the safety pins (Fig. 1, B). Each pin is then bent to form three alternating right angles (Fig. 1, C). The pins are then driven tightly through the holes in the block (Fig. 2). They may also be cemented in place.

The graft cover is used by centering it over the transplant and pressing the pin points into the plastic material until the cover rests evenly on the graft with sufficient pressure to hold it in place during healing.

This type of graft cover has the advantages of affording clear vision and of being easily manipulated, perfectly adjustable and of standard construction so that any one cover may be used for any graft, irrespective of the size or position of the embryo or the location of the transplant.

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A CULTURE SLIDE FOR DARK-FIELD MICROSCOPY

THE slide has a central circular stage about 3 mm in diameter which is surrounded by a circular moat approximately 0.9 mm deep and 4.5 mm wide at the top. The wall slopes away from the central stage so that the stage is at the upper surface of a truncated cone with a broad base. At a slight distance from the outer margin of the moat, a second narrow and shallow groove is cut in the glass, entirely encircling the moat. The surface of the central stage, the glass surface between the moat and the encircling groove, and the glass surface outside the groove are all on the same level so that a thin coverslip applied to the slide leaves only a capillary space between the under surface of the coverslip and the surface of the stage, while there remains a considerable space in the moat for culture medium to supply pabulum. The outer circular groove guards against contact of this medium with the vaseline or paraffin used for sealing the edge of the coverslip.

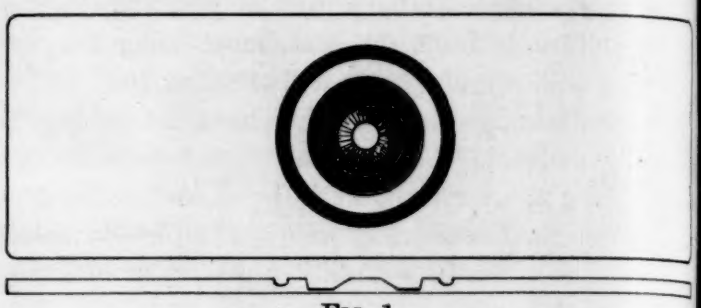

FIG. 1.

The upper drawing shows the pattern of the face of the slide. Below it is the pattern of the profile view of the median longitudinal section.

The measurements and the level of the stage may be varied in different models to meet special needs. At the present time two models are available. One of these is 1.15 to 1.20 mm thick for use with the Zeiss cardioid condenser and the paraboloid condenser of the Spencer Lens Company, and the other is 1.30 to 1.40 mm thick for use with the paraboloid condenser of Bausch and Lomb.

The slides are being made by C. A. Hausser and Son and may be obtained through Arthur H. Thomas Company, 230 South Seventh Street, Philadelphia, Penna.

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BOOKS RECEIVED

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EVE, A. S. and D. A. KEYS. *Applied Geophysics in the Search for Minerals.* Third edition. Pp. x + 316. Illustrated. Cambridge University Press, Macmillan. $4.25.

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GRANT, JULIUS. *Wood Pulp.* Pp. 209. Chronica Botanica, Leiden, Holland and G. E. Stechert, New York. $4.00.

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